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(54) METHOD FOR MANUFACTURING ULTRAFINE SHORT FIBERS

Abstract

The present invention pertains to a method for manufacturing ultrafine short fibers and is characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a polymer melt solution (spinning dope) along with heated air, which is supplied to an air nozzle (7), onto a collector (10) through a spinning nozzle (4), a high voltage is applied to each of the above-mentioned spinning nozzle (4) and collector (10) by a voltage applier (11). In the present invention, compared with the prior art, ultrafine short fibers can be manufactured with a high production efficiency and yield, and the stability is improved. The short fibers manufactured by the present invention are used for medical nonwoven fabrics and industrial nonwoven fabrics.

Representative figure:

Figure 3

Key words:

Ultrafine, short fiber, melt-blown, electrostatic spinning, voltage, high pressure, production efficiency, and yield

Specification

Brief description of the figures

Figure 1 is an outlined diagram showing the spinning process of the present invention.

Figure 2 is an outlined diagram showing a conventional melt-blown spinning process.

Figure 3 is an outlined diagram showing a conventional electrostatic spinning process.

Figure 4 is an outlined diagram showing a conventional solution spinning (flash spinning) process.

* Explanation of numerals of the main parts of the figures

1 Hopper
2 Extruder
3 Spinneret
4 Spinning nozzle
5 Capillary
6 Air gap
7 Air nozzle
8 Insulator layer
9 Short fiber

10 Collector
11 Voltage applier
12 Air compressor
13 Heater
14 Suction blower
15 Polymer solution
16 Polymer solution storage tank
17 Pressure pump
18 Decompression orifice
19 Spinning room
20 Solvent recovery device

Detailed explanation of the invention

PURPOSE OF THE INVENTION

TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

The present invention pertains to a method for manufacturing ultrafine fibers by spinning a polymer melt solution (spinning dope). More specifically, the present invention pertains to a method for manufacturing ultrafine fibers with high productivity and yield by spinning a polymer melt solution according to an electrostatic-melt blown spinning method.

In the present invention, "ultrafine short fibers" means short fibers (staple fibers) with a size (diameter) of several tens of nanometers or less. The ultrafine fibers are broadly used in various applications such as medical stitching nonwoven fabrics and industrial filters.

Conventional ultrafine short fibers have been manufactured mainly by an electrostatic spinning method, a solution spinning (flash spinning) method, or a melt-blown spinning method.

In Japanese Kokai Patent Application No. Hei 3[1991]-161502 and U.S. Patent No. 4,323, 525, methods for manufacturing ultrafine short fibers by the electrostatic spinning method are proposed.

Figure 3 is an outlined diagram showing a process for manufacturing ultrafine short fibers by the electrostatic spinning method. The electrostatic spinning method is a process for manufacturing short fibers by introducing a polymer solution (15) into an electric field. More specifically, it is a method that manufactures ultrafine short fibers by spinning (jets) a polymer solution through a spinning nozzle (4) having a + electrode and collecting it by a suction collector (10) having a – electrode.

However, in the above-mentioned electrostatic spinning method, although the size of the short fibers could be made fine, since solvents used in dissolving the polymer were unstable, there was a limitation in the mass production, and the productivity was inferior.

On the other hand, Figure 4 is an outlined diagram showing a process for manufacturing ultrafine short fibers by the conventional solution spinning method. It is a method that introduces a polymer solution in a storage tank (16) into a spinneret (3) by a pressure pump (17), prepares a high-temperature and high-pressure polymer solution by heating and pressurizing, and spins (jets) it onto a collector (10) through a spinning nozzle (4). However, in the above-mentioned solution spinning method, although the productivity was high and mass production was possible, since a high pressure was applied, it was dangerous; in particular, there was a limitation in making the size of the short fibers fine.

On the other hand, Figure 2 is an outlined diagram showing a process for manufacturing ultrafine short fibers by the conventional melt-blown spinning method. In the melt-blown spinning method, a polymer melt solution is prepared by melting a polymer in an extruder (2) and is spun along with heated air, which is supplied to an air nozzle (7), then onto a collector (10) through a spinning nozzle (4), so that ultrafine short fibers are manufactured. The heated air being jetted to the air nozzle (7) gives the polymer melt solution being spun a shear force and further improves the ultrafine processing of the fibers.

In the above-mentioned melt-blown spinning method, although the yield was excellent, compared with the solution spinning method and the electrostatic spinning method using the polymer solution, there was a limitation in ultrafine processing of the short fibers to a fixed level or less, that is, a level of several tens of nanometers (nm) or less.

The present invention solves these conventional problems; its objective is to provide a manufacturing method that can mass-produce ultrafine short fibers at a nanometer level with high productivity and yield.

TECHNICAL PROBLEMS TO BE SOLVED BY THE INVENTION

The present invention provides a method that can mass-produce ultrafine short fibers at the nanometer or lower level with high productivity and yield by organically combining a melt-blown spinning method and an electrostatic spinning method.

CONSTITUTION AND OPERATION OF THE INVENTION

In order to achieve the above objective, the method for manufacturing ultrafine short fibers of the present invention is characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a polymer melt solution (spinning dope) along with heated air, which is supplied to an air nozzle (7), onto a collector (10) through a spinning nozzle (4), a high voltage is applied to each of the above-mentioned spinning nozzle (4) and collector (10) by a voltage applier (11).

Next, the present invention is explained in detail using the attached figures.

The present invention is characterized by the fact that a melt-blown spinning method and an electrostatic spinning method are organically combined by applying a high voltage from a voltage applier (11) to the spinning nozzle (4) and the collector (10), with short fibers being manufactured by an ordinary melt-blown spinning method.

Figure 1 is an outlined diagram showing the process of the present invention.

In the present invention, first, a polymer melt solution (spinning dope) is prepared by supplying a thermoplastic polymer to an extruder (2) through a hopper (1) and melting it. As the polymer, all thermoplastic resins such as a polyester, polyamide, polacrylonitrile, polyurethane, and polyvinyl alcohol can be used. In the above-mentioned polymer melt solution, additives such as a resin, plasticizer, ultraviolet stabilizer, crosslinking agent, curing agent, and reaction initiator compatible with the corresponding polymer can also be mixed.

The spinning dope (polymer melt solution) prepared in this manner is transferred to a spinneret (3) and spun along with heated air through a spinning nozzle (4) into an electric field. The above-mentioned electric field is formed between the spinning nozzle (4) and a collector (10) to which a voltage is applied.

On the other hand, air compressed and heated by an air compressor (12) and a heater (13) is supplied to an air gap (6) and an air nozzle (7) formed on both sides of the spinneret (3), then spun along with the spinning dope through the spinning nozzle (4). The above-mentioned heated air gives the spinning dope a shear force and improves the ultrafine processing of short fibers.

Voltage is applied to the above-mentioned spinning nozzle (4) and collector (10) by a voltage applier (11). Thereby, an electric field is formed between them. At that time, the + electrode is applied to the spinning nozzle (4) and the – electrode is applied to the collector (10). It is preferable to adjust the voltage being applied to the spinning nozzle (4) and the collector (10) to 10-60 kV for an ultrafine processing of the short fibers. The same voltage can be applied to the spinning nozzle (4) and the collector (10), but different voltages can also be applied.

It is preferable to install an insulator layer (8) at the lower end of the above-mentioned spinneret (3) to prevent the voltage applied to the spinning nozzle (4) from being transmitted to the upper end of the spinneret (3). The above-mentioned collector (10) has a suction blower (14) for absorbing the air, and collects the spun short fibers in a web state.

In the present invention, since the polymer melt solution (spinning dope) is jetted with the heated air to the air nozzle (7) during spinning, it renders the shear force, and since the polymer melt solution is jetted into an electric field, the size of the short fibers (7) can be made fine, at a level of 50 nm or less. Also, in the present invention, since most of the conventional melt-blown spinning process is adopted as is, the productivity is high, and industrialization [mass production] is possible. Next, the present invention is explained in detail through application examples. However, the present invention is limited to the following application examples.

APPLICATION EXAMPLE 1

A spinning dope was prepared by supplying an isotropic pitch chip with a softening point of 240°C to an extruder, and melting it, then it was transferred to the spinneret (3) of Figure 1. Short fibers were then manufactured by melt blown-spinning the above-mentioned spinning dope through the spinning nozzle (4), to which the + electrode was applied, then onto the collector (10) to which the – electrode was applied. At that time, heated air at a pressure of 400 KPa was supplied at a wind velocity of 1,000 m^2/min to the air nozzle (7). Also, a voltage of 25 kV was applied to the spinning nozzle (4), and a voltage of 10 kV was applied to the collector (10). The size (average diameter) of the short fibers manufactured was 13 nm, and the production efficiency was 97.8%.

APPLICATION EXAMPLE 2

A spinning dope was prepared by supplying a polyester chip with a softening point of 265°C to an extruder, then melting it, then it was transferred to the spinneret (3) of Figure 1. Short fibers were then manufactured by melt blown-spinning the above-mentioned spinning dope through the spinning nozzle (4), to which the + electrode was applied, to the collector (10) to which the – electrode was applied. At that time, heated air at a pressure of 400 KPa was supplied at a wind velocity of 1,000 m^2/min to the air nozzle (7). Also, a voltage of 30 kV was applied to the spinning nozzle (4), and a voltage of 30 kV was applied to the collector (10). The size (average diameter) of the short fibers manufactured was 15 nm, and the production efficiency was 98.9%.

EFFECTS OF THE INVENTION

According to the present invention, the size of short fibers can be made ultrafine, to a level of several tens of nanometers or less, and the above-mentioned ultrafine short fibers can be mass-produced with high productivity and high yield.

(57) Claims

1. A method for manufacturing ultrafine short fibers, characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a polymer melt solution (spinning dope) along with heated air, which is supplied to an air nozzle (7), onto a collector (10) through a spinning nozzle (4), a high voltage is applied to each of the above-mentioned spinning nozzle (4) and collector (10) by a voltage applier (11).

2. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that an insulator layer (8) is installed at the lower end of the spinning nozzle (4).

3. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that the voltage being applied to the spinning nozzle (4) and the collector (10) is 10-60 kV.

4. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that a + electrode is applied to the spinning nozzle (4) and a – electrode is applied to the collector (10).

Figure 1

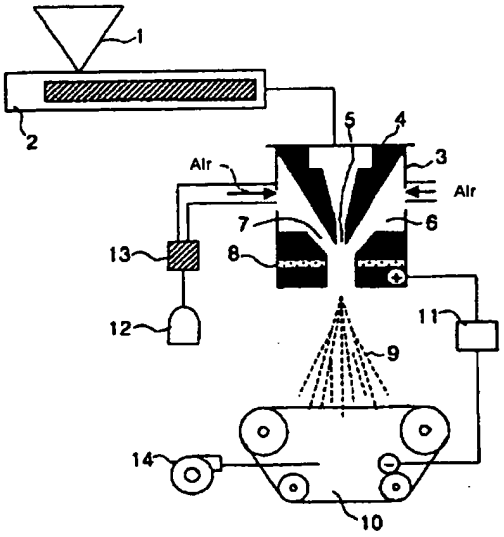

Figure 2

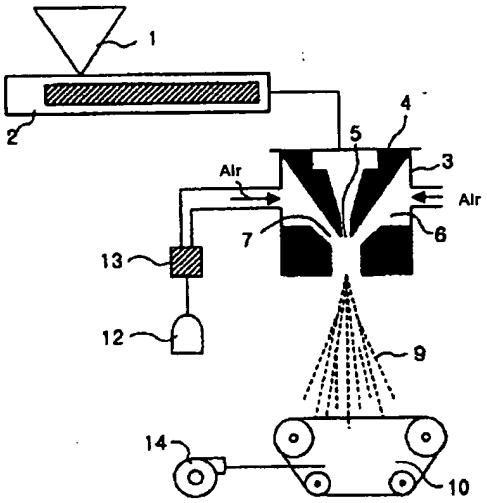

Figure 3

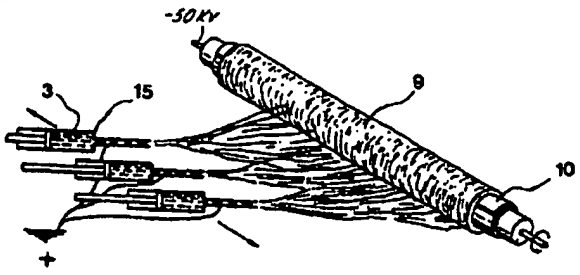

Figure 4